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## SPECTROGRAPHIC DETECTION OF RARE EARTHS IN PLANTS

The spectrograph is being applied to an ever-increasing extent in both the qualitative and quantitative analysis of materials. This instrument, which identifies the chemical elements by light emitted under suitable excitation conditions, is especially valuable in the examination of complex materials for which chemical analysis may be impractical. An interesting example of the value of spectrographic analysis was the recent examination by Bourdon F. Scribner of a material separated from plant ash.

This substance was obtained from hickory leaves in the course of the investigation of the chemical composition of plant materials, undertaken by the Bureau of Chemistry and Soils. Since the substance could not readily be identified by chemical means, it was submitted to the National Bureau of Standards with a request for spectro-

graphic test. With the aid of a grating spectrograph, Mr. Scribner made an examination for 64 chemical elements, and was able to identify the sample as a mixture of rare earths, nearly free of common elements.

The rare earths constitute a group of 13 transition elements lying between lanthanum and hafnium in the periodic system and, in addition, scandium, yttrium, and lanthanum, which have similar properties. The rare earths are found as mixtures in small amounts widely distributed in the earth's crust. They have been found in plant and animal tissues but usually in very small quantities. The rare-earth concentrate from the hickory leaves, however, amounted to 0.2 percent of the dry weight of the leaf, equaling the concentration of  $\text{SiO}_2$  in the sample and exceeding the  $\text{MnO}$ , which is 0.15 percent, and  $\text{Na}_2\text{O}$ , which is 0.02 percent. The source of the rare earths in this case was, no doubt, the pegmatite vein in which the sample was growing.

Because of the possible influence of the rare earths on the plant, it appeared worth-while to examine further into the

<sup>1</sup> Published with approval of the Director of the Budget.

occurrence of these elements. Several samples of hickory leaves from different localities, birch and sweet-leaf leaves, and of black raspberries were subjected to chemical treatment at the Bureau of Chemistry and Soils to concentrate the rare earths, after which the concentrates were examined spectroscopically at the National Bureau of Standards. Rare earth elements were found in every concentrate tested, the number varying from 4 to 13 elements.

The following elements were detected: Scandium, yttrium, lanthanum, cerium, praseodymium, neodymium, samarium, europium, gadolinium, terbium, dysprosium, erbium, and ytterbium. The remaining three rare earths—holmium, thulium, and lutetium—were not detected in the samples.

In view of the effect of certain rare constituents, such as boron, on plant growth, the possibility of modification of growth characteristics by the rare earths should not be overlooked. It is planned, therefore, to make a further investigation of the subject.

#### TURBULENCE OF WIND STREAMS

Everyone is familiar with the fact that the wind seldom blows with uniform and steady speed. Usually the wind is gusty; its speed rises and falls in an irregular manner. This behavior is characteristic of the flow of air in nearly all cases of technical interest—in ventilating ducts, around the blades of fans and propellers, and near the surfaces of aircraft, and so forth. The technician speaks of such a flow as a turbulent flow, considering the actual motion as made up of a steady motion on which a turbulence is superposed.

About 15 years ago the Bureau, with the cooperation and financial assistance of the National Advisory Committee for Aeronautics, began a study of the fundamental aspects of turbulence in connection with the practical problem of standardizing methods of making tests of aircraft models in wind tunnels. Wind tunnels are designed to give as steady an air flow as possible, so as to reproduce the same relative motion between model and air as between an aircraft in flight and the surrounding air. Some turbulence is always present. In many cases the flow around the model and hence the forces acting on it depend on the amount and nature of this turbulence.

The Bureau has developed and continuously improved methods of measuring the intensity of the turbulence, that

is, the magnitude of the speed fluctuations. Recently methods of measuring the scale of the turbulence have also been developed, that is, the average extent in space of the gusts. From work at the Bureau and elsewhere, it has been found that the turbulence in wind tunnels is isotropic, the intensity of the fluctuations being independent of the direction in which the fluctuations are measured. Recently a more complete description has been obtained in terms of the spectrum of the turbulence, a curve giving the intensity of the fluctuations as a function of frequency.

Along with these studies, the effect of isotropic turbulence on the flow very close to the surface of an object immersed in the stream has been investigated. The nature of the turbulence within this boundary layer has also been studied.

At the Fifth International Congress for Applied Mechanics held at Cambridge, Mass., September 12-16, 1938, the work of the Bureau on turbulence was briefly reviewed by Hugh L. Dryden, chief of the Division of Mechanics and Sound, as part of a symposium on this subject, in which many international authorities took part. This review will be published in the proceedings of the Congress.

#### AIR FLOW IN THE BOUNDARY LAYER

In modern high-speed aircraft, the friction of the air over the surface—the so-called skin friction—makes a considerable contribution to the drag, and is one of the important factors limiting the speed of the craft. For this reason skin friction is being given a great deal of attention at present, and investigations are being conducted to discover the origin of air friction.

The nature of the flow over the surface of a body, or, more exactly, the flow in the boundary layer near the surface, determines to a large extent how great the skin friction will be. For example, the flow in the boundary layer may be either laminar or turbulent, and if the flow is turbulent the skin friction will be several times as great as it will be if the flow is laminar. In general, the flow in the boundary layer remains laminar for a certain distance from the point where the boundary layer begins (the leading edge of a wing or the nose of an airship), then becomes turbulent at a point called the transition point and remains turbulent thereafter.

In the Bureau's aerodynamics section G. B. Schubauer has investigated the boundary layer formed on the surface of an elliptic cylinder, having major and minor axes of 11.78 and 3.98 inches, respectively, and a length of 54 inches. It was placed in the 54-inch wind tunnel with the major axis of the ellipse parallel to the wind. Speed distributions across the boundary layer were determined with a hot-wire anemometer at several points about the surface, with the stream turbulence as low as possible in one case and as high as possible in another. It was found that stream turbulence had a marked effect on both the nature of the transition and on its position on the surface. To obtain additional information on the difference between the laminar and turbulent parts of the layer, the intensity and frequency of the speed fluctuations in the layer were studied.

After these general characteristics of the layer had been investigated, a detailed study was made of the effect of turbulence on the position of the transition point. The turbulence was produced by placing a square-mesh screen ahead of the cylinder, the intensity being varied by placing the screen at different distances from the cylinder. The scale, or eddy size, of the turbulence was varied by using screens of different mesh size, the larger mesh producing the larger scale. For each condition of scale and intensity the position of transition on the cylinder was measured. It was found that the position of transition could be expressed as a function of intensity divided by the fifth-root of the scale of the turbulence, in accordance with the theory of G. I. Taylor.

This investigation, which was conducted with the cooperation and financial assistance of the National Advisory Committee for Aeronautics, was discussed by Mr. Schubauer in a paper before the Fifth International Congress for Applied Mechanics, held in Cambridge, Mass., September 12-16, 1938. The paper will be published in the proceedings of the Congress.

#### MEASUREMENT OF RELATIVE AND TRUE POWER FACTORS OF AIR CAPACITORS

Insulating oil for use in power transmission has been so improved in recent years that it is now possible to produce oil having such low electrical losses that ordinary methods of measuring these losses are unsatisfactory. Difficulties encountered in the measurements,

which are made in an alternating-current bridge, are mainly due to the influence of stray fields on the bridge, to earth capacitance and leakage effects within the bridge, and to the uncertainty of the losses in the capacitors of the bridge which serve as standards of power loss or power factor.

In the Journal of Research for October (RP1138), Allen V. Astin describes a bridge and capacitors in which these difficulties are overcome to the extent that power factors as small as  $5 \times 10^{-7}$  can be detected in the commercial and audio-frequency range. This is equivalent to saying that when an alternating voltage is applied to a capacitor it can be determined whether as little as five ten-millionths of the energy passing through the capacitor is dissipated within it.

The bridge is a variation of the type developed by Schering and is used with a Wagner ground, which brings the bridge detector to ground potential and reduces the effect of stray electrical fields on the bridge. The influence of such fields is further reduced by very thorough shielding, and the effect of stray magnetic fields is kept low by keeping the amount of inductance in the bridge at a minimum.

The bridge can be operated with full sensitivity over a fairly wide voltage range. Two forms of the bridge are used for this purpose; the low-voltage form covering the range from 20 to 100 volts, and the high-voltage form from 500 volts up to the safe limit of the available capacitors, which at present is about 2,000 volts.

Since power-factor measurements by a bridge method give difference in power factor of two capacitors, it is desirable to have available a capacitor of variable capacitance, the power factor of which is so stable that it can serve as a standard against which the power losses in other capacitors can be compared. It is shown that ordinary capacitors are unsatisfactory for this purpose, primarily because of the instability of the power losses in their solid insulation. In the capacitors which have been developed for use as power-factor standards, the losses in the solid insulation are eliminated by the introduction of guard electrodes.

It is also desirable to have a method for evaluating the power factor of the capacitor which serves as a power-loss standard. A method is described for accomplishing this evaluation, so that it is possible to give the actual power-factor value of the standard capacitor and of other capacitors which are compared with it.

### A DETERMINATION OF THE ABSOLUTE OHM

In 1921, a modification of the treaty establishing the International Conference on Weights and Measures was adopted, giving the conference authority to establish and maintain the electrical units. At the 1933 meeting of the conference the decision was reached to establish units based on the absolute system. All the national laboratories were requested to carry out experiments to fix the absolute values of these units, since the laboratories at the International Bureau of Weights and Measures were not equipped to make them. In the Journal of Research for October (RP1137), progress on a part of the international program is reported. The purpose of this investigation, conducted by Harvey L. Curtis, Charles Moon, and C. Matilda Sparks, was to determine the value of the Bureau's primary standards of resistance in absolute ohms. This required a series of complicated electrical and mechanical measurements of such a character that, if these measurements were perfect, the result obtained would depend only on the units of length and of time, and on the magnetic permeability, relative to that of a vacuum, of certain materials used in the construction of the necessary apparatus. Since some imperfections are always present in the apparatus, and since there are always errors in the measurements, the value determined for a resistance in absolute ohms is always somewhat uncertain. The present work was undertaken to reduce this uncertainty.

The authors are of the opinion that their final result,

$$1 \text{ NBS international ohm} = 1.000479 \text{ absolute ohms,}$$

does not differ from the true value by as much as 20 parts in a million. In order to attain this accuracy, the standard meter bar, to which all length measurements were referred, would have to be accurate to 0.02 millimeters. Expressed in larger units, the length standard would have to be sufficiently accurate to permit measuring a mile with an accuracy of an inch. Likewise, the error of the time standard could not exceed one second in a day. Both these standards were known with much greater accuracy than required. Hence the uncertainty in the final value is largely the result of errors in measurement. Work is in progress to reduce these errors.

### HEATS OF COMBUSTION OF COKE AND GRAPHITES

The heats of combustion of 30 samples of anthracite cokes have been determined by Phillip H. Dewey and D. R. Harper, 3d. These cokes were of known different temperatures of preparation (900° to 1,300° C), and had hydrogen contents from 0.08 to 0.78 percent, and adsorptive capacities ranging from 0.13 to 37.5 ml of gaseous carbon dioxide per gram of solid carbon, so that the effect of these properties on the heat content of the materials could be studied. As shown in RP1139 in the October Journal of Research, data were also obtained on the heats of combustion of two samples of pure ash-free artificial graphite and four different samples of natural graphite.

### HEATS OF COMBUSTION OF DIAMOND AND GRAPHITE

Data on the heats of combustion of the various forms of carbon are of considerable interest in thermochemistry, because carbon is present in all organic compounds, and a value for the heat of combustion of some form of carbon must be used in calculating the heats of formation of practically all such compounds. Most previous measurements of heats of combustion of the various forms of carbon were made some time ago, and the results obtained by various experimenters are not in satisfactory agreement. Some of the data, for example, indicated that graphite was not a definite, reproducible substance, but that its heat of combustion varied somewhat, depending upon the treatment to which the graphite had been subjected. Since these data were obtained, some improvements have been made in the technique of heat-of-combustion measurements and in methods of interpreting the data of such experiments. New work on the heats of combustion of the various forms of carbon, therefore, appeared to be justified.

A project described in the October Journal of Research (RP1140) was part of a joint investigation undertaken by the Bureau and the Coal Research Laboratory of the Carnegie Institute of Technology. The Bureau's work, which was carried out by Ralph S. Jessup, included measurements of the heats of combustion of two natural graphites, one artificial graphite, and two samples of powdered diamond. It has been found that when the graphites were purified the heats of combustion

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of the three samples were the same within 0.02 percent, which is within the uncertainty of the measurements. The results obtained by Jessup are in practically perfect agreement with those obtained by the Coal Research Laboratory. The results obtained by the two institutions show that graphite is a definite, reproducible substance, at least so far as its heat of combustion is concerned.

The results on the diamond samples were not quite so satisfactory, since the values obtained for the heats of combustion of the two samples differed by 0.12 percent. This difference is several times the uncertainty of the value for either sample. One of the samples of diamond was much more finely powdered than the other, and the difference in the observed heats of combustion is in the direction to be expected from the relative sizes of the particles, but it is greater in magnitude than was predicted. It may be that the effect of particle size has been underestimated.

#### HEAT AND FREE ENERGY OF FORMATION OF CARBON DIOXIDE

In calculating the heat of a chemical reaction it is important to have accurate values for the heats of formation of each of the various compounds involved in the reaction. For a large number of organic compounds, the heats of formation can be most readily obtained from the heats of combustion of the compounds, together with values for the heats of formation of carbon dioxide and water. Measurements of the heat of formation of water were made at the Bureau a number of years ago, and the value resulting from these measurements has been accepted by the Committee on Thermochemistry of the International Union of Chemistry as the standard value for use in calculating the heats of formation of organic compounds.

The situation in regard to the heat of formation of carbon dioxide has not been so satisfactory. Some of the data, for example, indicated that carbon in the form of graphite was not a definite substance, but that different samples of graphite differed in their energy content by quite significant amounts. This situation has been greatly improved by a recent joint investigation by Frederick D. Rossini and Ralph S. Jessup of the Bureau's Chemistry and Heat Divisions in cooperation with the Coal Research Laboratory of the Carnegie Institute of Technology in Pittsburgh. In this in-

vestigation, measurements were made of the heat of combustion of crystalline carbon, both in the form of diamond and in the form of graphite.

In the Journal of Research for October (RP1141), Rossini and Jessup review the existing data on the entropies of oxygen, carbon dioxide, graphite, and diamond, and those on the heats of combustion of natural and artificial graphite and diamond, including the recent results obtained in the investigation mentioned above. The new thermochemical data are combined with values of the entropies to obtain values for the heat and free energy of formation of carbon dioxide, and of the transition from graphite to diamond. The selected values for these constants are as follows:

For C (c, graphite) + O<sub>2</sub> (g) = CO<sub>2</sub> (g), at 25° C per mole,  $\Delta H^\circ = -393,355 \pm 46$  NBS international joules, or  $-94,030 \pm 11$  calories, and  $\Delta F^\circ = -394,228 \pm 58$  NBS international joules, or  $-94,239 \pm 14$  calories.

For C (c, graphite) = C (c, diamond), at 25° C and 1 atmosphere,  $\Delta H = 1,899 \pm 124$  joules, or  $454 \pm 30$  calories, and  $\Delta F = 2,872 \pm 129$  joules, or  $686 \pm 31$  calories. For this transition, the following equation is derived, with some approximations, for the range  $T = 273^\circ$  to  $1,400^\circ$  K, and  $P = 0$  to 20,000 atmospheres:

$$\Delta F = 541.82 + 6,700/T + 1.17662T \log T - 2.43723T^2 - 0.000221T^3 - [0.045660 + 0.91236 \times 10^{-6} T - 0.7830 \times 10^{-10} T^2 - 0.3623 \times 10^{-12} T^3] P + 0.19 \times 10^{-6} P^2 \text{ calories per mole.}$$

In all the foregoing values, conversion from the NBS international joule to the conventional calorie is made with the factor 1/4.1833.

#### HIGH-VACUUM STILL AND BOILING-POINT APPARATUS FOR PETROLEUM FRACTIONATION

The American Petroleum Institute, through its Research Project 6 at the Bureau, has been engaged for several years in the investigation of the constituent hydrocarbons in petroleum. The work was begun on the naphtha fraction of an oil from a well in the South Ponca field of Oklahoma. Later, the work was extended to the lubricant fraction from the same oil. The supply of this oil available was too small to hope to isolate constituents from it, but it was possible to demonstrate the nature of the constituents. To continue the investigation of the actual constituents a supply of the lubricant fraction of an oil from the Oklahoma City

field was obtained. Before shipment to the Bureau, 240 gallons of the material were distilled in a semicommercial vacuum still and cut into nine approximately equal fractions of distillate and a residue.

For further fractionation by distillation in the laboratory, R. T. Leslie and W. W. Heuer constructed a continuous high-vacuum still, evacuated by a Cenco-Hypervac mechanical pump and three oil diffusion pumps. As described in RP1142 in the *Journal of Research* for October, the first distillation of the oil in this still was run at 12 to 15 liters an hour, the second and third at about 1 liter an hour, with the take-off valve regulated to return 75 percent of the distillate to the top of the still. An apparatus was then built for determining the boiling points of the distillate and the residue at 1 mm Hg, and for the third distillation all materials were charged into the still as nearly as possible in order of boiling points.

751 kg of distillate and 11 kg of residue remained after the three distillations. This indicates a shrinkage of 40 kg, part of which was due to gases and very low-boiling material which were dissolved in the heavy fractions and were distilled out at low pressures. Large volumes of material concentrated chiefly in four temperature ranges: 185° to 200° C, 210° to 220° C, 230° to 240° C, 245° to 250° C. Comparison of the distillation graph with that of the naphtha fraction showed similarity in the number of volume concentrations, but considerably less variation in the refractive index in the lubricant fraction.

It was concluded from the slight variation in the refractive index that most of the hydrocarbons of higher molecular weight contained both ring and chain structures and were, therefore, not strictly paraffinic, naphthenic, or aromatic. It was further concluded that the concentrations in volume of distillate were caused by families of hydrocarbons differing by units of structure, probably six-membered carbon rings.

#### PROCEDURE FOR MAKING A SOIL-CORROSION SURVEY

A description of the procedure for conducting a soil-corrosion survey has been prepared by I. A. Denison of the Bureau for publication in the *Pipe Line Number* of the *Oil and Gas Journal*. This procedure is based upon a comparison between results of tests of the corrosiveness of soil samples taken along the right-of-way of an extensive pipe-line system, and the actual cor-

rosiveness of the soils, as shown by a record of leaks and repairs extending over a period of 45 years. The corrosiveness of the soils was tested by measuring the voltage of corrosion cells after various current densities were applied. As the electrolytic test was successful in predicting the corrosiveness of a large proportion of the soils along the right-of-way of the pipe-line system, it appears that the test might be used practically in determining which sections of a pipe line should be protected from corrosion. An analysis of the pipe-line data, the nature of the correlation obtained, and the influence of soil properties on the rate of corrosion will be described in a forthcoming number of the *Journal of Research*.

The survey procedure consists of the following operations: (1) classification of the soil types along the pipe-line route, (2) tests of the corrosiveness of the soil samples by means of the electrolytic corrosion test and arrangement of the soil types according to the predicted order of corrosiveness, and (3) application of an economic method, in which the cost of protective coatings is balanced against the cost of repairing leaks and reconditioning an unprotected line, in order to decide in what soil types coatings should be applied to make the annual cost of maintenance a minimum.

#### RECENT DEVELOPMENTS RELATED TO UNDERGROUND CORROSION

At the request of the editor of the *Oil and Gas Journal*, K. H. Logan, chief of the Bureau's underground corrosion section, has prepared an article in which he calls attention to, and in some cases describes briefly, recent developments in this field. In cases where there are published articles on the new developments references to them have been given. New pipe materials, protective coatings, cathodic protection, and corrosion tests are mentioned and commented upon. Some of the new developments are mentioned because of their novelty rather than on account of their proven value.

#### LOW-COST GLAZES FOR STRUCTURAL CLAY PRODUCTS

An increasing demand has arisen among manufacturers of brick, tile, and similar products for inexpensive glazes for application to their wares for ornamental, sanitary, or weather-resisting purposes.

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The number of plants making glazed brick and tile by application of the glaze mixture to the ware before firing is small, and manufacturers who contemplate entering the field of glazed products are seldom equipped with the technical knowledge or personnel needed to develop glazes suitable for their clays, kilns, and manufacturing conditions. An investigation of low-cost glazes is, therefore, being made by R. T. Stull and P. V. Johnson to demonstrate the method by which such glazes can be made.

The general scheme involved in the investigation is to develop glazes consisting largely of the same clay as that used in the product to which the glaze is to be applied.

The clays included in the investigation are a shale from Illinois, a shale and a fire clay from Ohio, a shale and a fire clay from Pennsylvania, and three surface clays from Maryland. The deformation or "softening point" eutectics are determined for mixtures of the clays with whiting or with other low-cost fluxes, such as pulverized limestone, dolomite, witherite, colemanite, and galena. Colemanite, as a source of  $B_2O_3$ , and galena containing lead may be used advantageously as fluxes for producing glazes maturing at low temperatures.

The eutectic mixture serves as the basis for the glaze, and its composition (if need be) is modified by the addition of suitable glaze-making material to form a good glaze at the temperature to which the ware is to be fired.

The range in composition of shale and whiting to form the eutectics for the three shales is from 72 shale+28 whiting to 70 shale+30 whiting. All three eutectic compositions form good mat glazes of the so-called "lime-iron green" color, and good glazes of high gloss are made by replacing 15 parts of the shale by 15 parts of potter's flint.

The eutectic compositions of the three surface clays lie within the limits of 75 clay+25 whiting and 72 clay+28 whiting. The silica contents of the surface clays are sufficiently high to insure that all three eutectic compositions will form good bright glazes. These glazes, and also those made for the shales, mature at approximately  $1,135^\circ$  to  $1,155^\circ$  C, and glazes maturing as low as  $1,050^\circ$  C are obtained by substituting either colemanite or galena for about half of the whiting, replacing 1 part of whiting by either 2.40 parts of galena or 2.06 parts of colemanite. The two fire clays, however, are deficient in silica and require the addition of potter's flint to form both mat and bright glazes.

## CRUSHING RESISTANCE OF ENAMELS

The resistance of enamels to mechanical wear may be considered as the resultant of two components, namely, (1) the resistance of the surface layer to abrasion, and (2) the resistance of the underlying enamel structure to crushing. The first of these types of wear occurs, for example, in scrubbing an enamel surface with a cleansing powder. (The chemical action of such powders is not under consideration in the present discussion.) Both types of wear may be involved in the scratching of an enamel with a gouging tool, rolling cutter, or other implement of similar action, since the surface is penetrated and also the understructure is crushed or torn. Since the resistance of enamels to these types of wear is not necessarily proportional, it is essential to test for each one separately in order to deal effectively with the causes and remedies for the respective types of wear.

The test for resistance to surface abrasion, which was referred to in Technical News Bulletin 247 (November 1937), has been adopted as a tentative standard by the Porcelain Enamel Institute, after experimental work in which members of the Institute cooperated.

A test for crushing resistance of enamels has recently been studied at the Bureau by W. N. Harrison and L. Shartsis, and wide differences between different enamels have been found. The test consists essentially of rolling a small ball bearing, under various known loads, on the surface of the enamel and observing the load required to gouge out a path in the enamel.

The use of a ball bearing, which may be replaced as often as necessary, eliminates the difficulty which has been found in obtaining identical gouging tools, and maintaining them in a given shape, even diamonds having been found to wear significantly. The difficulty of determining the end point, that is the load at which gouging occurs, is also reduced by the use of a ball bearing, since its path in the enamel has been found to be sufficiently broad, when it occurs at all, to be readily distinguished.

As the loads are increased beyond that at which crushing begins, greater percentages of the total path of the ball are gouged out. By arbitrarily establishing a given percentage as the end point, comparable results can be obtained. For close determination of

this percentage, a micrometer microscope is used.

By means of this test, definite differences in the crushing resistance of different areas on one 4-by-6-inch specimen were found. Also different enamels have required loads varying from less than 20 to more than 100 pounds to cause crushing.

#### WEAR RESISTANCE OF CONCRETE FLOORS

This Bureau has recently investigated the wear resistance of cement mortars and concretes of the type used for flooring. Wear was produced by rotating steel disks moving in a circular path on 23- by 27- by 1-inch slabs of mortars and concretes, varying from a 1:2 mortar mix to a 1:3:6 concrete mix. An abrasive between the disks and the slabs was supplied by an automatic feed. The actual depth of wear was observed with a specially designed optical gage. The effects of different cements, cement-water ratios, troweling procedures, dust coats, curing conditions, metallic hardeners, and liquid hardeners were studied.

Large differences in wear resistance were found for such factors as time of troweling and length of damp-curing period, delayed troweling and longer damp curing as a rule increasing the resistance to wear. Mixes having the same cement-water ratio, but different proportions of cement, sand, and aggregate varied widely in their wear resistance. For example, a mix of 1 part of cement to 2 parts of sand gave about twice the wear that was given by a mix of 1 part of cement to 1½ parts of sand and 2 parts of coarse aggregate, although each mix had a cement-water ratio of 2.26. The metallic hardeners were quite effective in reducing the wear, but the liquid hardeners were not materially effective in the mixes studied.

The details of the test procedures and complete results will be reported in a future number of the Journal of Research.

#### STRUCTURAL PROPERTIES OF LOW-COST HOUSE CONSTRUCTIONS

There is a great need at present for houses at much lower cost. Many new constructions have been suggested and some experimental structures have been built, but the information available at present (especially on constructions fabricated from unusual mate-

rials and by new methods) is not sufficient to allow engineers and architects to determine whether a given construction has adequate strength. To provide this much-needed information, the Bureau is conducting a number of special investigations of these newer types of construction, with special reference to their suitability for low-cost houses and apartment buildings.

The methods of conducting certain investigations are described in the second publication of the Bureau's new series on building materials and structures, BMS2, entitled "Methods of Determining the Structural Properties of Low-Cost House Constructions," copies of which are obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 10 cents each. This paper describes methods in use at the Bureau to determine the structural properties of elements of a low-cost house; that is, structural properties of wall specimens under compressive, transverse, concentrated, impact, and racking loads; of partition specimens under impact and concentrated loads; of floor specimens under transverse, concentrated, and impact loads; and of roof specimens under transverse and concentrated loads. A graphic method of presenting the results of the tests is also described. It is believed that the tests of house constructions by these methods will give information on the structural properties which will greatly assist in the selection of a low-cost construction for given conditions.

Examples of special construction, to be included in this research program, must comply with the requirements set forth in BMS2 as to size, price, etc., and the necessary test specimens must be delivered gratis at the laboratory in Washington. The specimens may be walls, partitions, floors, or roofs. No charge will be made for the tests, and the results on each construction will be published for the information of everyone interested.

#### COMMERCIAL STANDARD FOR FUEL OILS

The rapid increase in the use of fuel oil, particularly for residential heating, is no doubt largely due to the effective work by refiners and scientific laboratories in the grading of oils to insure uniformity of the product. This makes possible a basis for approval of burners by underwriters and provides a means for specifying and certifying the proper

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grade of oil for each type of burning equipment. The large amount of work done in this field is embodied in the latest edition of Commercial Standard CS12-38, Fuel Oils (4th ed.), which has just been issued.

The third edition of this Commercial Standard, a revision of the second edition, covered the more important characteristics of satisfactory burning oils. Six distinct grades were described with limits of flash point, pour point, water and sediment, carbon residue, ash, distillation range, and viscosity. Experience has indicated the advantage of limiting the above characteristics so as to provide a better classification for competition and an improved system of designating quality, which before the appearance of definite grade standards was limited only by gravity—an index having very little significance so far as suitability of an oil for use in a burner was concerned.

The Commercial Standard as originally published in 1929 covered domestic and industrial fuel oils. Oils used for heat treatment, glass, and ceramic furnaces, and other special uses, must sometimes have a low sulfur requirement. To meet these special needs, the standard was revised to carry a table showing permissible maximum sulfur content for each grade. This revision was published in 1933 under the abbreviated title Fuel Oils (2d ed.), Commercial Standard CS12-33.

The third edition, CS12-35, sought to prevent overlapping of grades and misrepresentation in supplying a lighter oil than indicated by the grade number.

The present edition continues to define both upper and lower limits for each grade, and reduces the number of grades from six to five, by the elimination of No. 4. The range of Grades 1, 2, and 3 has been reduced materially in the direction of a lighter oil. The revision was recommended by the standing committee, which is composed of representatives of refiners, fuel-oil distributors, burner manufacturers, and consumer organizations, including a number of the members of Technical Committee E, Committee D-2, of the American Society for Testing Materials. It has been endorsed by important oil refiners, burner manufacturers, distributors, and users, estimated to represent a satisfactory majority. The standard became effective for new production on May 31, 1938, subject to the expiration of existing contracts.

The pamphlet which includes, in addition to the standard specification, a list of acceptors and a brief history of

the project, is obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents a copy.

#### COMMERCIAL STANDARD FOR MARKING OF ARTICLES MADE WHOLLY OR IN PART OF PLATINUM

A voluntary commercial standard, CS66-38, for marking of platinum and part platinum articles has just been released. Authentic quality marks for platinum, either alone or in combination with other metals of the platinum group, such as iridium, palladium, ruthenium, rhodium, and osmium, as well as combinations of platinum and gold, have been a troublesome matter within the industry. One difficulty pertains to the substitution of palladium, a lighter metal, for platinum without revealing its presence and proportion.

On July 16, 1937, the Jewelry Crafts Association requested the cooperation of the Bureau in establishing a commercial standard for marking platinum articles, based upon the New York Platinum Law and similar laws in New Jersey and Illinois, in order that quality marks on items containing this precious metal might be uniform throughout the United States.

A proposed standard conforming to the laws of the three above-mentioned States was referred to more than a score of trade associations, distributor and consumer organizations, for comment, and the response indicated that, except for minor improvements in the wording, those directly concerned endorsed the proposal.

Following the preliminary conferences in New York City on October 5, 1937, and January 27, 1938, the proposed standard was circulated to the trade for acceptance. On receipt of written acceptances representing approximately 75 percent in volume of production, an announcement was made to the trade on May 20, 1938, that the standard would become effective as of June 20, 1938, for new production, and as of June 20, 1939, for clearance of existing retailer stocks.

The commercial standard establishes terminology, definitions, abbreviations, and minimum requirements for quality marks on platinum and part-platinum articles, and requires that these quality marks shall be accompanied by trademarks registered in the United States to fix responsibility for quality.

The printed pamphlet includes the exemptions, a brief history of the project, a list of official acceptors, and the membership of the standing committee. Copies are available from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents each.

#### COMMERCIAL STANDARD FOR MARKING KARAT-GOLD ARTICLES

A Commercial Standard for the marking of karat-gold articles, CS67-38, has just been released. For a long time there has been a conviction among manufacturers and retailers of gold jewelry that the National Stamping Act of 1906 should be strengthened and extended to protect the consumer, to promote better understanding between buyer and seller, and to provide for fair competition.

Owing to the difficulties of revising National laws, heightened by some divergence of opinion on details, the New England Manufacturing Jewelers' and Silversmiths' Association, after some preliminary conferences on the subject, requested the cooperation of the Bureau in establishing a Commercial Standard on a voluntary basis for marking articles made of karat gold.

The objectives of the standard are as follows: (1) To establish a minimum of 10 karat for gold articles bearing a quality mark; (2) to require that the quality mark shall be accompanied by a trade-mark registered under United States laws to fix responsibility; (3) to prohibit loading or weighting of gold articles bearing quality marks; (4) to prevent the misrepresentation of other precious metals as gold; and (5) to eliminate the term "solid gold," except as applied to fine gold.

In the beginning, it was also proposed to reduce the rather broad tolerances permitted by the National Stamping Law, but it was soon evident that nothing could be accomplished in this direction by voluntary methods so long as a few manufacturers continue to take advantage of the wide legal tolerances which give them a decided price advantage over competitors. However, at the public hearing it was the unanimous opinion that the tolerances provided by the National Stamping Law are too liberal and should be restricted. Accordingly, a technical committee on tolerances was appointed to make recommendations to the industry concerning revision of the National Stamping Law tolerances.

The standard records definitions for the terms "gold," "karat gold," "fine gold," and "solid gold"; it establishes a minimum of 10 karat for gold articles bearing a quality mark; it requires that quality marks shall be accompanied by a name or trade-mark registered under the laws of the United States to fix responsibility for the quality marks; it prohibits loading or weighting of gold articles bearing quality marks; and includes a recommended wording of a certificate or label to indicate that the article is marked in strict conformity with the Commercial Standard.

While the standard perforce recognizes the tolerances of the National Stamping Law as applied to the usual quality marks, it also provides that when an article is guaranteed to assay not less than a specified fineness, no tolerance shall be permitted below the specified fineness, as revealed by the assay.

The standard became effective for new production on November 25, 1938, and for clearance of existing retailer stocks on November 25, 1939. Copies of the Commercial Standard may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents each.

#### COMMERCIAL STANDARDS FOR DISINFECTANTS, DEODORANTS, AND GERMICIDES

Several pamphlets of interest to housekeepers, not only in individual homes but also in larger institutions, such as hotels, schools, hospitals, theaters, and public buildings of all kinds, have just been issued under the titles: Liquid Hypochlorite Disinfectant, Deodorant, and Germicide, Commercial Standard CS68-38; Pine Oil Disinfectant, CS69-38; Coal Tar Disinfectant (emulsifying type), CS70-38; Cresylic Disinfectants, CS71-38; and Household Insecticide (liquid spray type), CS72-38.

These pamphlets comprise the nationally recognized standards of quality for their respective products, and cover the composition, physical and chemical properties, identification, methods of packing, and certification of quality.

The purpose of these Commercial Standards is to provide minimum specifications for quality, as a basis for understanding and voluntary guarantees between producers, distributors and users, and to serve as foundations for confidence on the part of purchasers that the efficacy of the materials is

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what should be expected of disinfectants, deodorants, and germicides, manufactured in conformity with nationally recognized specifications.

These pamphlets include brief histories of each project, the membership of the standing committees organized to review suggestions for revision to keep the standards abreast of progress, and lists of acceptors.

Copies of any of these pamphlets are obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents each.

# **NEW AND REVISED PUBLICATIONS ISSUED DURING SEPTEMBER 1938**

## **Journal of Research<sup>2</sup>**

Journal of Research of the National Bureau of Standards, volume 21, number 3, September 1938 (RP1129 to RP1136, inclusive). Price 30 cents. Annual subscription, 12 issues, \$3.50.

## **Research Papers<sup>2</sup>**

[Reprints from June and July 1938 Journal of Research]

RP1102. An electric hygrometer and its application to radio meteorography. Francis W. Dunmore. Price 15 cents.

RP1103. New procedure for the analysis of dental gold alloys. Raleigh Gilchrist. Price 10 cents.

RP1105. Supercooling and freezing of water. N. Ernest Dorsey. Price 5 cents.

RP1106. Thermal expansion and effects of heat treatments on the growth, density, and structure of some heat-resisting alloys. Peter Hidnert. Price 10 cents.

RP1107. Heats of hydration and transition of calcium sulfate. Edwin S. Newman and Lansing S. Wells. Price 5 cents.

RP1108. Reproducibility of the silver-silver chloride electrode. Edgar Reynolds Smith and John Keenan Taylor. Price 5 cents.

RP1109. Influence of copper and iron salts on the behavior of leather in the oxygen bomb. Joseph K. Kanagy. Price 5 cents.

RP1113. Displacement of nitrogen from and its solution in certain reagents during volumetric gas analysis. Joseph R. Branham and Max Sucher. Price 5 cents.

## **Reports on Building Materials and Structures<sup>2</sup>**

EMS2. Methods of determining the structural properties of low-cost house constructions. Herbert L. Whittemore and Ambrose H. Stang. Price 10 cents.

## **Simplified Practice Recommendations<sup>2</sup>**

R41-38. Package sizes for agricultural insecticides and fungicides. (Supercedes R41-26.) Price 5 cents.

R170-38. Spice containers (tin and fiber). Price 5 cents.

R171-38. Wooden boxes for canned fruits and vegetables. Price 5 cents.

## **Commercial Standards<sup>2</sup>**

CS12-38. Fuel oils. (4th ed.) (Supercedes CS12-35.) Price 5 cents.

CS66-38. Marking of articles made wholly or in part of platinum. Price 5 cents.

CS67-38. Marking articles made of karat gold. Price 5 cents.

CS68-38. Liquid hypochlorite disinfectant, deodorant, and germicide. Price 5 cents.

CS69-38. Pine oil disinfectant. Price 5 cents.

CS70-38. Coal tar disinfectant (emulsifying type). Price 5 cents.

CS71-38. Cresylic disinfectants. Price 5 cents.

CS72-38. Household insecticide (liquid spray type). Price 5 cents.

## **Technical News Bulletin<sup>2</sup>**

Technical News Bulletin 257, September 1938. Price 5 cents. Annual subscription, 50 cents.

<sup>2</sup> Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 50 cents per year; Journal of Research, \$3.50 per year (United States and its possessions, and Canada, Colombia, Cuba, Dominican Republic, Ecuador, Guatemala, Honduras, Mexico, Newfoundland (including Labrador), Panama, and Venezuela); other countries, 70 cents and \$4.50, respectively.

<sup>2</sup> Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 50 cents per year; Journal of Research, \$3.50 per year (United States and its possessions, and Canada, Colombia, Cuba, Dominican Republic, Ecuador, Guatemala, Honduras, Mexico, Newfoundland (including Labrador), Panama, and Venezuela); other countries, 70 cents and \$4.50, respectively.

# **RECENT BUREAU ARTICLES APPEARING IN OUTSIDE PUBLICATIONS<sup>2</sup>**

The American Standard for electrical indicating instruments. H. B. Brooks. Am. Standards Assn. (29 West 39th St., New York, N. Y.), ASA No. C39-1-1938.

Measurements of the equivalent luminous intensity of rotating beacons. G. K. Neeland, M. K. Loffler, and W. R. Schaub. J. Optical Soc. Am. (Cornell University, Ithaca, N. Y.) 28, 280 (August 1938).

The nature of the ionosphere storm. S. S. Kirby, N. Smith, and T. R. Gilliland. Phys. Rev. (11 East 38th St., New York, N. Y.) 54, 234 (August 1, 1938).

Underground corrosion of pipe. K. H. Logan. Chem. & Met. Eng. (330 West 42d St., New York, N. Y.) 45, 422 (August 1938).

Note on the method of least squares and the thermoelectric power of rhodium. H. T. Wensel and L. B. Tucker.

erman. Rev. Sc. Instr. (Cornell University, Ithaca, N. Y.) 9, 237 (August 1938).

Neutron scattering cross sections of para and orthohydrogen, and of N<sub>2</sub>, O<sub>2</sub>, and H<sub>2</sub>O. F. G. Brickwedde, J. R. Dunning, H. J. Hoge, and J. H. Manley. Phys. Rev. (11 East 38th St., New York, N. Y.) 54, 266 (August 15, 1938).

Specifications for a precision mapping camera. Irvine C. Gardner. Photogrammetric Eng. (American Society of Photogrammetry, P. O. Box 18, Benjamin Franklin Station, Washington, D. C.) 4, 173 (July-August-September, 1938).

Gyroscopic instruments for instrument flying. W. G. Brombacher and W. C. Trent. Technical Note 662 (Nat. Advisory Com. Aero., Washington, D. C.) (September 1938). (Free on application to Committee.)

Fatigue testing of wing beams by the resonance method. William Bleakney. Technical Note 660 (Nat. Advisory Com. Aero., Washington, D. C.) (August 1938). (Free on application to Committee.)

Regular polyhedroids. L. B. Tucker. Science (Grand Central Terminal, New York, N. Y.) 88, 216 (September 2, 1938).

<sup>2</sup> These publications are not obtainable from the Government unless otherwise stated. Requests should be sent direct to the publishers.

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